**RESPIRATORY SYSTEM**

* Main Functions

1. Gas Exchange (O2 🡨🡪CO2)
2. Sound Production (vocalization)
3. Olfaction (more important function in animals)

* Respiratory Tract

1. Nasal Cavity

* Provides air conditioning (↑ or ↓ temperature)

1. Pharynx (throat)

* Common passageway for air and food

1. Larynx

* Voice box
* Epiglottis
* flips and covers entry to voice box – prevents food from going into the trachea
* controlled by ANS (voluntary – cannot be controlled when you are unconscious!)
* Vocal folds – taut CT – changes in tautness + vibration = sound
* Sexual dimorphism of vocal quality comes from shape of folds

1. Trachea

* Has distinct cartilage rings which help keep trachea patent
* Pseudostratified ciliated epithelium – secreted mucus traps debris
* Mucociliary escalator – wave motion of cilia propels mucus upwards
  + Chronic smokers have ↓ mucus, which causes cilia damage

1. Bronchi

* Lined with cartilage
  + ∴ they cannot collapse

1. Bronchioles

* Smooth muscle
* Last segments before alveoli
* Not lined with cartilage
  + ∴ they can collapse (ie: asthma)

1. Alveoli (singular: alveolus)

* FUNCTIONAL UNIT OF THE LUNGS
* Respiratory Membrane (allows gas exchange) only 0.5µm in thickness!

1. Alveolar epithelium (Type I (squamous) cells)
2. Capillary endothelium
3. Basement membrane

Exchange = diffusion – driven by a concentration gradient

* Type II Cells
  + Produce surfactant, which ↓ surface tension, allowing alveoli to collapse and inflate with breathing
  + CL – Infant Respiratory Distress Syndrome (IRDS)
    - Happens to premature babies
    - Research 🡪 discovery of Type II cells and their function 🡪 Type II cells don’t produce surfactant until pregnancy is full-term ∴ premature babies’ alveoli cannot properly inflate and deflate (due to too much surface tension)
* Dust cells
  + Specialized macrophages which phagocytize debris
  + Products of phagocytosis carried away by mucociliary escalator
* Respiratory Process

1. Ventilation

* air in and out of tract

1. External Respiration

* gas exchange between air and blood

1. Transport of Gases

* by Hemoglobin – the only molecule that can bind with O2
* (CO2 can bind to Hb too, but is also carried by plasma and bicarbonate)

1. Internal Respiration

* Gas exchange between blood and tissue (cells)

1. Cellular Respiration

* Cells are ultimate users of O2
* Mitochondria + O2 🡪 ATP
* Pulmonary Ventilation
* Boyle’s Law (P1P2=V1V2)  
  ↑ volume 🡪 ↓ pressure  
  ↓ volume 🡪 ↑ pressure
* Inspiration  
  ↑ Diaphragm 🡪 ↑ thoracic volume 🡪 ↓ intrapulmonary pressure 🡪 air flows in
* Factors affecting ventilation

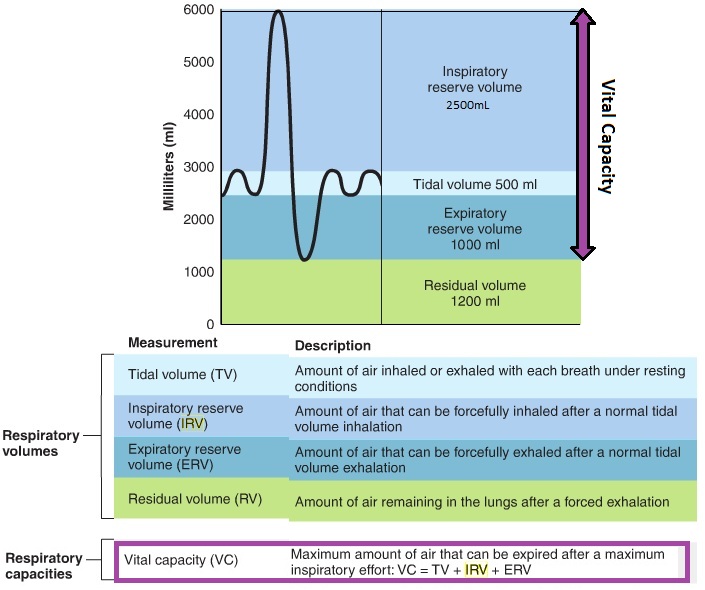
1. Airway resistance

* Ex: bronchiole constriction 🡪 asthma

1. Alveolar surface tension

* ↑ surface tension 🡪 collapse alveoli
* Ex: IRDS

1. Lung compliance

* ↓ by infection/inflammation 🡪 limited expansion
* Ex: fibrosis 🡪 ↓ distensibility
* Uncommon
* Respiratory Volume

1. TV: ~500mL
2. IRV: 2500mL
3. ERV: 1000mL
4. VC: 4000mL

* VC = TV + IRV + ERV  
  4000 = 500+2500+1000
* Gas Exchange
* A matter of concentration gradients
* Partial Pressure
  + Air: 79% N2, 21% O2
  + PO2: 760 \* 21% = =159mmHg
    - P = partial pressure
* External Respiration (gas exchange between air and blood)

1. O2

PO2 alveoli: 104mmHg *🡨 why is this <159mmHg?? Because of old air in lungs*

PO2 pulmonary artery: 40mmHg

1. CO2  
    PCO2 vein: 45mmHg

PCO2 alveoli: 40mmHg

* Internal Respiration (gas exchange between blood and cells)

1. O2

PO2 artery: 104mmHg

PO2 tissue: 40mmHg

1. CO2  
    PCO2 tissue: >45mmHg

PCO2 artery: 40mmHg

* O2 loading and unloading

1. O2 – Hb saturation curve

* Rapid binding/rapid dissociation

1. Bohr Effect

* ↑ temp, ↑ PCO2 , ↓ pH 🡪 ↑ O2 release
  + These conditions happen every time we exercise – the effect helps us stay oxygenated
* CO2 transport in the blood

1. Plasma – 10%
2. Hb – 2-% - globulin is the part that can carry CO2 (heme carries O2)
3. Bicarbonate – 70%

* CO2 + H2O 🡨🡪 H2CO3 🡨🡪 H+ + HCO3-
  + H2CO3 = carbonic acid
  + HCO3- = bicarbonate
* CO2 is 20x more soluble than O2
* Bicarbonate is very important as a blood buffer, but also bears the function of CO2 transportation.
* Control of Respiration
* Neural mechanisms
  + Respiratory reflex

1. Baroreceptor reflex (more common)

Ex: ↓BP 🡪 carotid/aortic baroreceptor 🡪 medulla 🡪 ↑ respiration rate

1. Chemoreceptor reflex

Ex: ↑ PCO2 🡪 chemoreceptor in carotid body 🡪 medulla 🡪 ↑ respiration rate

* Also maintains blood pH (its more important function)
* Respiratory Disorders
* Asthma
* Bronchiole constriction + mucus secretion
* Emphysema
* Destruction of alveolar surface 🡪 impaired gas exchange and difficulty exhaling